Durability Testing of CBRN Powered Air-Purifying Respirators (PAPR)

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NIOSH/NPPTL Public Meeting

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Durability Testing Includes: Environmental, Transportation and Rough Handling

- Purpose/Goal
- Assumptions
- Types of Tests and Conditions of PAPR
  - Minimum Packaging Configuration (MPC)
  - Battery to undergo Environ & Trans in MPC
- Rationale for the Test

Purpose/Goal

Purpose of Tests: Perform environmental storage, transportation shock and drop tests on the CBRN PAPR to qualify durability and to detect any initial life cycle failures that may occur from typical use

Goal: To ensure CBRN PAPR provides adequate respiratory protection after being subjected to normal environmental storage, transportation and rough handling conditions by the user

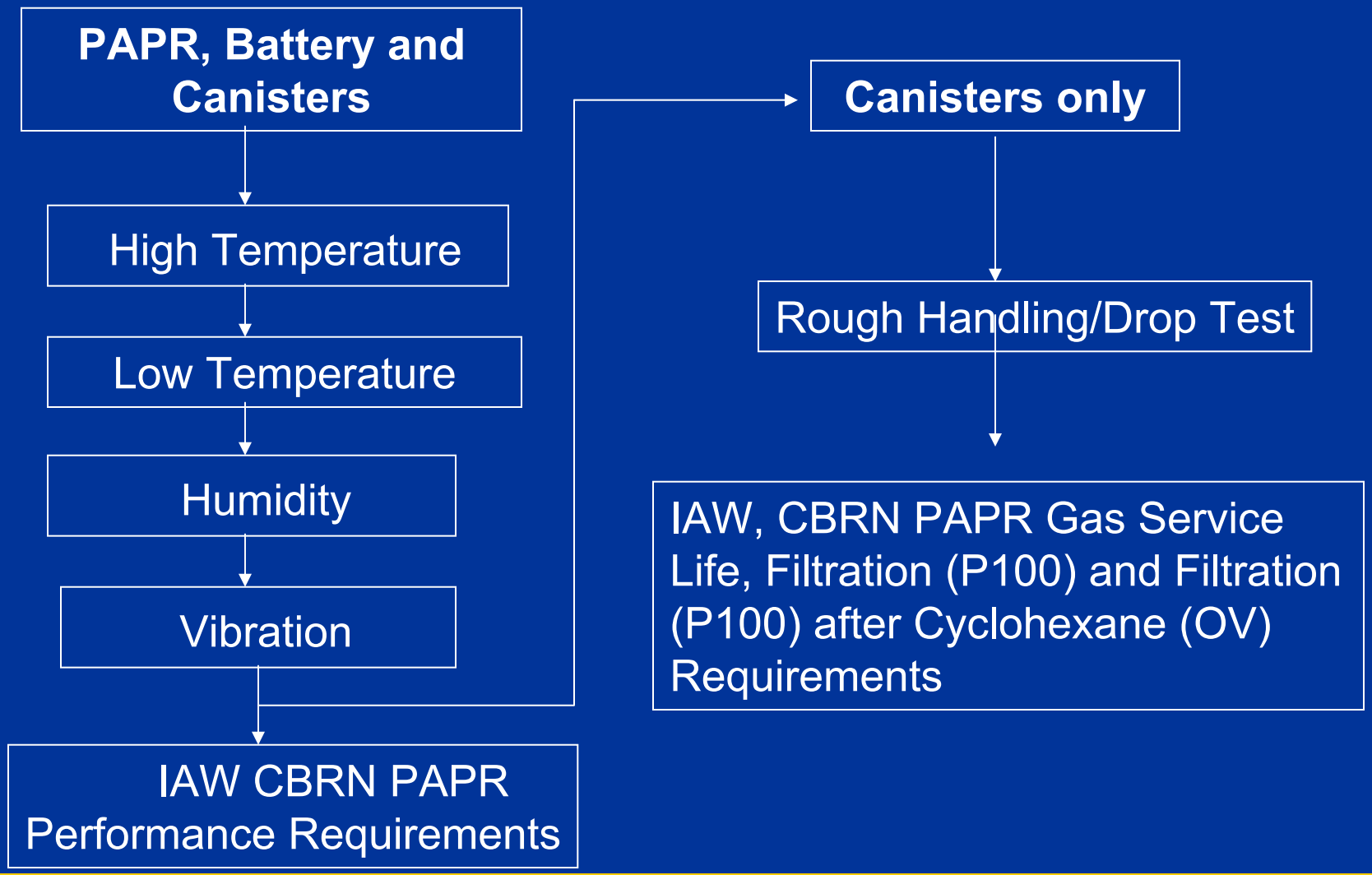
Assumptions

- Tests represent conditions induced by the user that a CBRN PAPR may experience from the point of issue
- Maintenance and inspection shall be performed IAW applicable Department of Labor, OSHA Title 29 CFR 1910.134(h)
- Non-industrial use scenario – for CBRN emergency use only

Assumptions (Continued)

- Test conditions tailored to realistic U.S. meteorological weather conditions, U.S. roadway transportation conditions and typical first responder use rough handling conditions (i.e., not worst case)
- Potential for PAPR to experience these U.S. conditions by some users (i.e. car trunk vs. police station)
- Tests not intended to represent entire life cycle but rather to identify potential initial life cycle failures
- Mil-Spec 810-F used as principle guidance document

Types of Durability Tests



Test Conditions of PAPR

- CBRN PAPR and Canisters will be subjected to the test conditions in the Minimum Packaging Configuration (MPC) as recommended by the manufacturer in User Instructions

- Batteries will be conditioned in the MPC:
  - Immediately after Durability in ambient conditions, conditioned batteries will be installed in PAPR and PAPR is required to be functional (No Time Limit)
  - Batteries will be Recharged/Replaced after functional testing and before performing the subsequent GB and HD testing

Minimum Packaging Configuration

1. Minimum Packaging Configuration (MPC) is the protective packaging that *End User shall store or maintain the PAPR and components inside after issue

2. The User's Instructions (UI) shall identify the MPC and shall direct the *End User how to store or maintain the PAPR and the components while in their possession

3. The level of MPC, if any, is left to the discretion of PAPR manufacturer

4. Over cases, packaging or shipping containers provided by Mfgrs over MPC will not be used in Durability Testing

Minimum Packaging Configuration (Cont.)

*End User:

-- The person who will derive protection from the PAPR by wearing it

-- It is assumed the end user will be responsible for PAPR storage

Environmental Storage

1. **High Temperature**
   - **Mil-Std-810F, Method 501.4, Table 501.4-II, Hot-Dry Diurnal Cycle, Hot-Induced Conditions 35^0C (95^0F) to 71^0C (160^0F), 24 Hour Cycle, 3 Weeks**

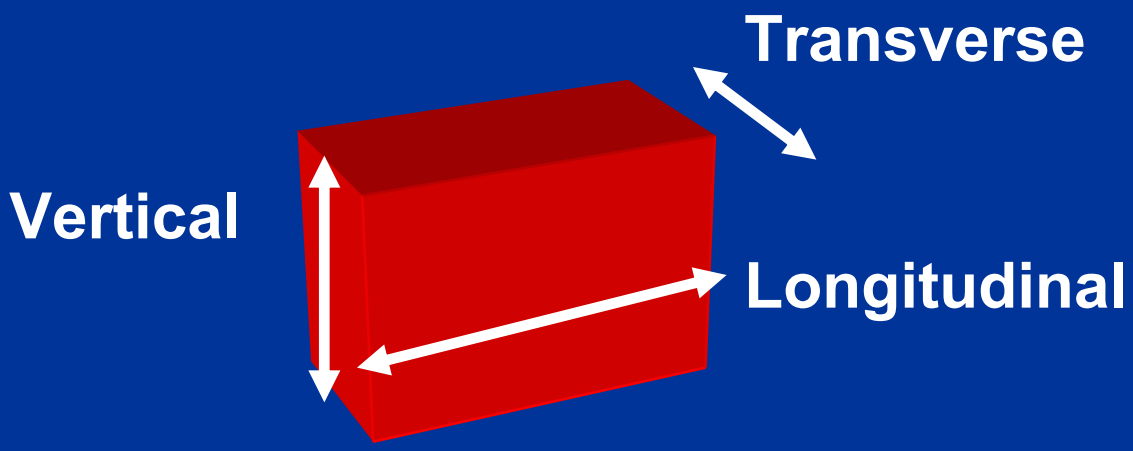
2. **Low Temperature**
   - **Mil-Std-810F, Method 502.4, Basic Cold, Constant Temperature at –31^0C (– 24^0F), 3 Days (72 Hours)**

3. **Humidity**
   - **Mil-Std-810E, Method 507.3, Figure 507.3-I (cycle 1), Natural Diurnal Humidity Cycle, 5 Days**
   (“quick look”)
   (range 88^0F @ 88% RH – 105^0F @ 59% RH,
   24 hr period)

Transportation

Vibration

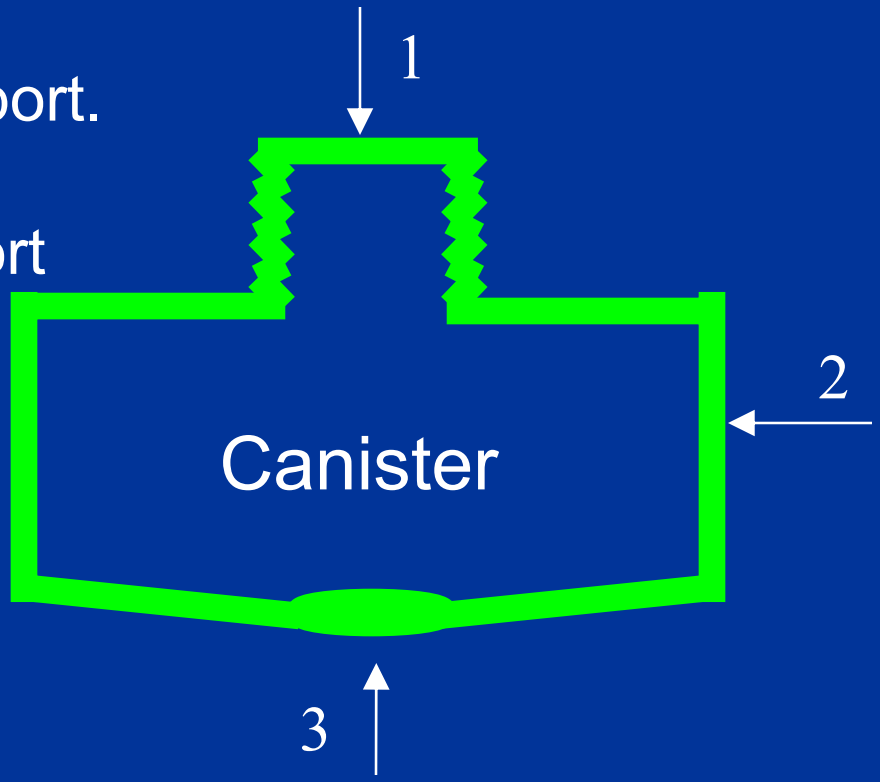
MIL-STD-810F, Method 514.5, Vibration, Annex A, Category 4, Over U.S. Highways, 60 minutes per 1,000 miles of road travel per axis, 3 Axis, 12 Hours per axis (36 hours total = 12,000 miles), Unrestrained



Rough Handling: Drop Test (Canisters Only)

Drop 3 feet onto a concrete surface; Each canister dropped once; a canister is dropped once on one of the following axis:

(1) Major axis vertical, air outlet port.
(2) Major axis horizontal.
(3) Major axis vertical, air inlet port



Rationale for the Test

High Temperature: Simulates storage in trunk of vehicle; Induced conditions: solar loading/diurnal profile representative of southwest U.S. climates; Duration based on prior RDECOM (Formerly SBCCOM) experience with mask testing

Low Temperature: Representative of minimum temperature in U.S. intermediate zones per Mil-Std-810F (Basic Cold); Duration is minimum 810F recommended exposure period

Humidity: Represents natural temperature humidity profile in humid regions of U.S. per Mil-Std-810F; Duration is minimum Mil-Std-810F recommended exposure period

Vibration: Simulates vehicle transport of total of 12,000 miles on U.S. roadways in a unrestrained configuration

Rough Handling: Simulates drop or fall from vehicle or table-top

Durability Testing
Issues, Testing & Timelines

- **Issues:**
  - Battery Survivability
  - Containment Fixture Size
  - Test Procedures
- **Testing:**
  - Bench Mark Testing: 4 to 5 PAPRs / *Mfgr
  - Verification Test: 4 to 5 PAPRs / *Mfgr
- **Timelines:**
  - Complete Bench Mark Testing: Jul 2004
  - Complete Verification Testing: Oct 2004

* Minimum of 3 Manufacturers

Durability Test Matrix

Test	Test Method	Test Conditions	Duration	Pass/Fail Threshold
Hot Diurnal	Mil-Std-810F 501.4	(35^{0}C/ 95^{0}F) to (71^{0}C/ 160^{0}F), 24 Hour cycle	3 Weeks Diurnal Cycle	PAPR, Battery and Canisters **NOTE:** Batteries in MPC as indicated by Users Instructions. Applicable NIOSH CBRN PAPR requirements
Cold Constant	Mil-Std-810F 502.4	Basic Cold, -32^{0}C (-24^{0}F), Constant	3 Days	
Humidity	Mil-Std-810E 507.3	Realistic, Natural Cycle Humidity Profiles in the U.S. (range 88^{0}F @ 88%RH– 05^{0}F @ 59%RH, 24 hr period)	5 Days "quick look" Mil-Std-810E Table 507.3-II	
Transportation Vibration	Mil-Std-810F 514.5	U. S. Roadway Vibration, Unrestrained	12 hours/axis, 3 Axes Total duration = 36 hours = 12,000 miles	

Drop Test: In Minimum Packaging Configuration	Canisters Only	1 drop per filter (on one of the 3 axis)	Height of 3 feet	Gas Service Life, Filtration (P100) and Filtration After OV Gas Life